DISTURBANCE ECOLOGY OF THE SOUTHERN APPALACHIANS

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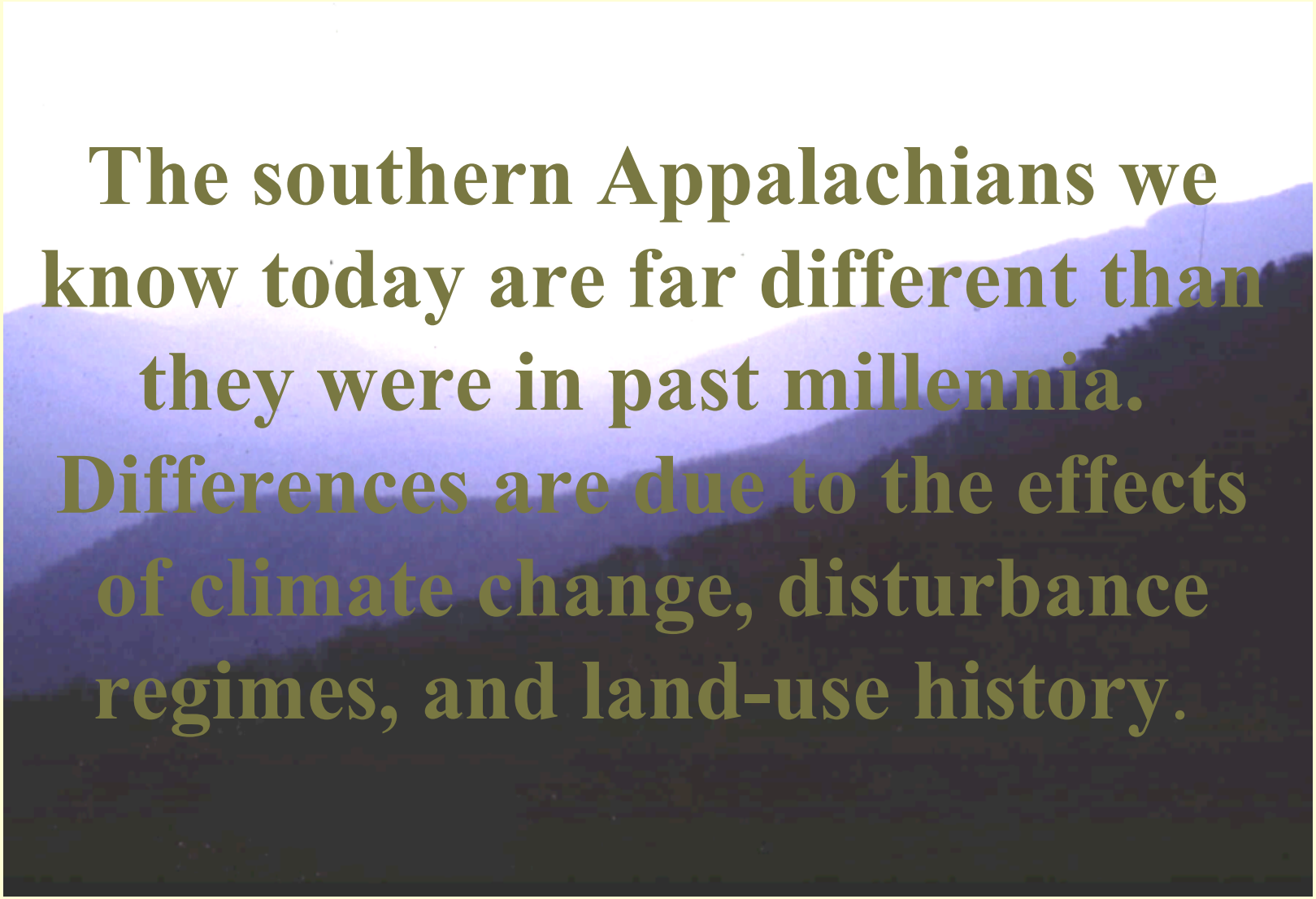
10th Annual Hardwood Silviculture Training Course

Bent Creek Experimental Forest



SOUTHERN APPALACHIAN MOUNTAINS

Disturbance = a force that causes significant change in structure and/or composition of ecosystems through natural or anthropogenic events

Disturbance ecology is the study of these changes resulting from natural or anthropogenic causes

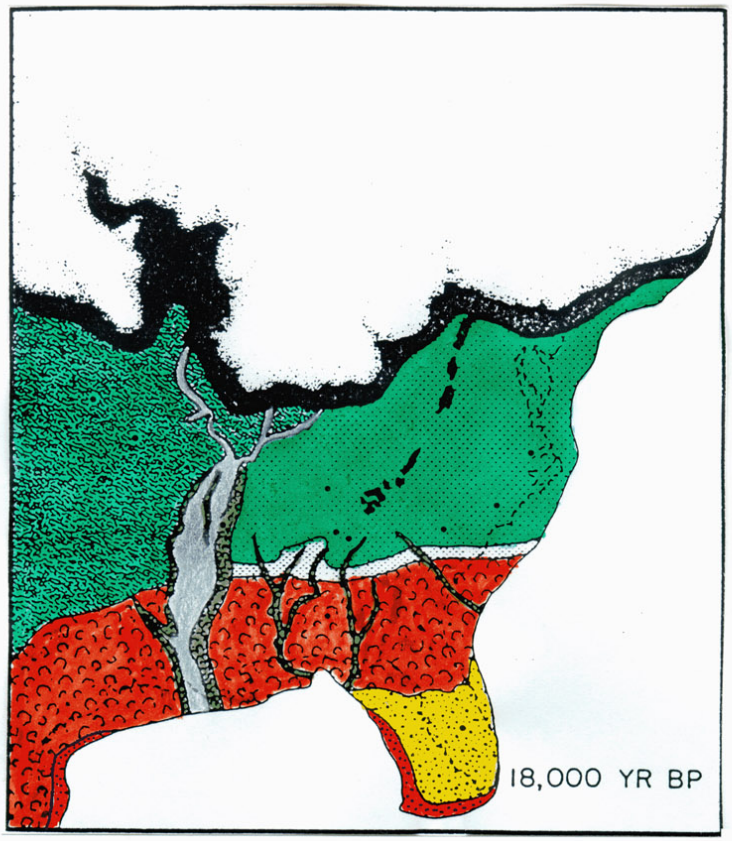
I will attempt to tie disturbance ecology to the climate changes, disturbance regimes, and land-use history that shaped vegetative patterns since the last ice age.

Climate Changes

At the peak of the Wisconsin glaciation 18,000 years ago, the southern Appalachians were far different than today. Although unglaciated, the climate was much colder and drier. Tundra vegetation covered the mountain tops and spruce-Jack pine forests occupied the slopes.

Oak-hickory and southern pine forests were pushed far to the South by the cold temperatures. Mesophytic species found refuge in the southern river bottoms.

The climate of the entire Southeast was very arid for thousands of years as the ice sheets moved south.



LEGEND

Laurentide Ice Sheet

Tundra

Boreal Forests

spruce-jack pine

jack pine-spruce

spruce open

Southeastern-Evergreen Forests

oak-hickory southern pine

cypress-gum

sand dune scrub

Decidous Forests

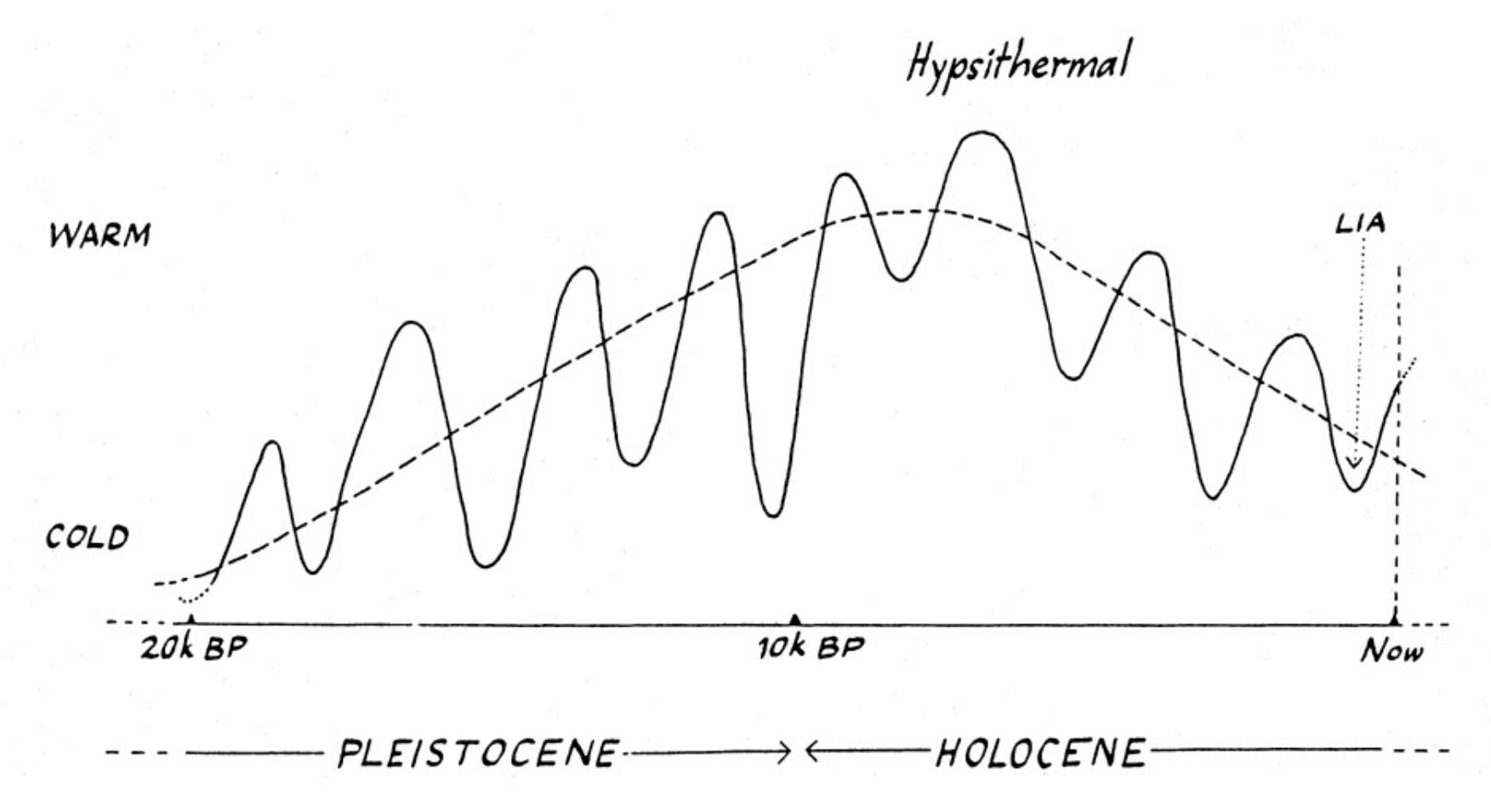
mixed hardwood

mixed-conifer-northern hardwoods

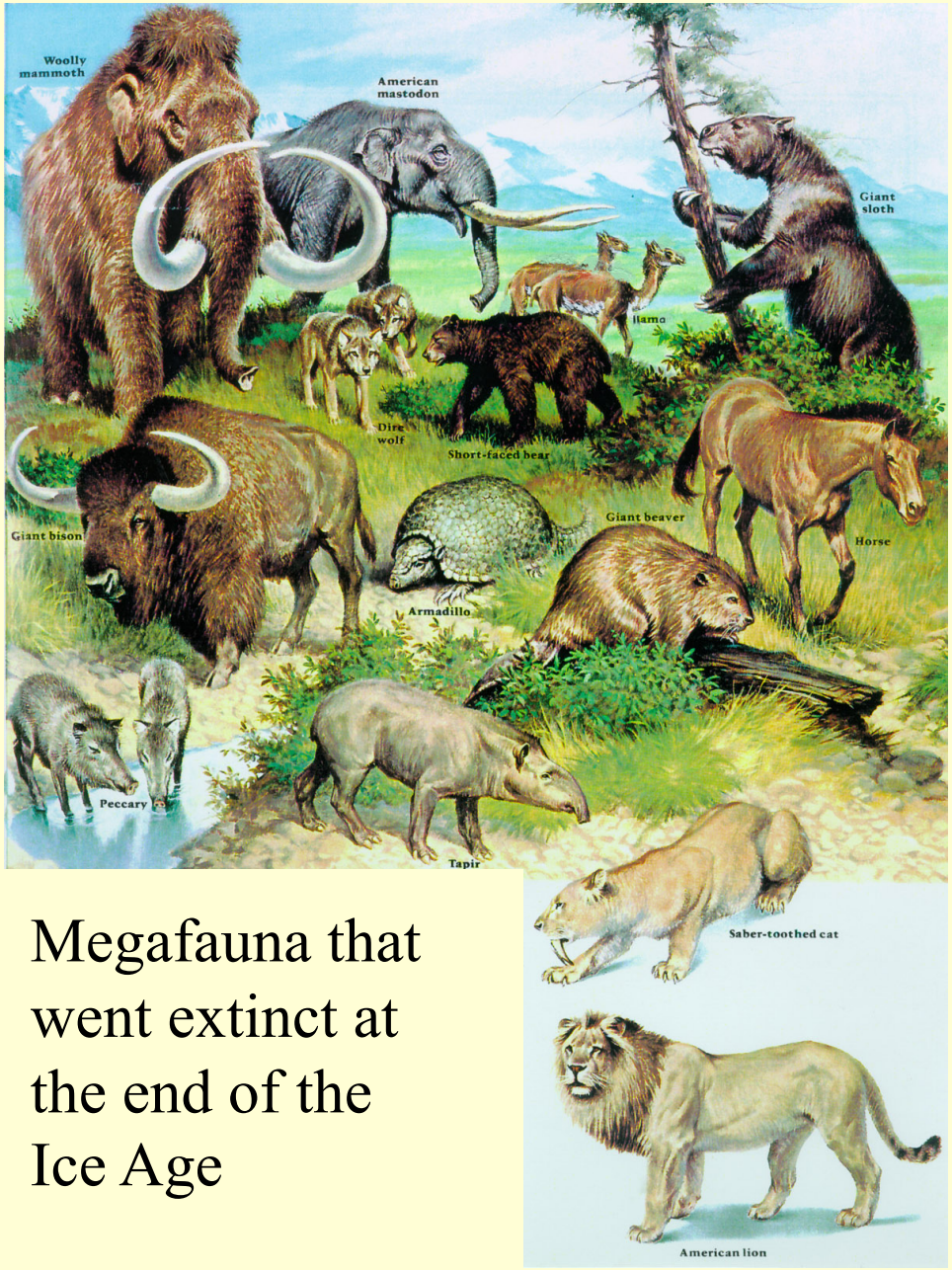
As the climate warmed (there were cycles of cooling and warming within this general warming trend), plant species moved north and west. Climatic change during the retreat of the glaciers was so pronounced that it probably contributed to the great wave of megafauna extinctions.

By 9,500 years ago, oak species already dominated the mid-South. During the Hypsithermal Period (7,500 – 5,000 years ago), temperatures were higher than at present. Pollen profiles indicate that an oak-hickory-pine association dominated the East. Anthropogenic burning helped create and maintain this association.

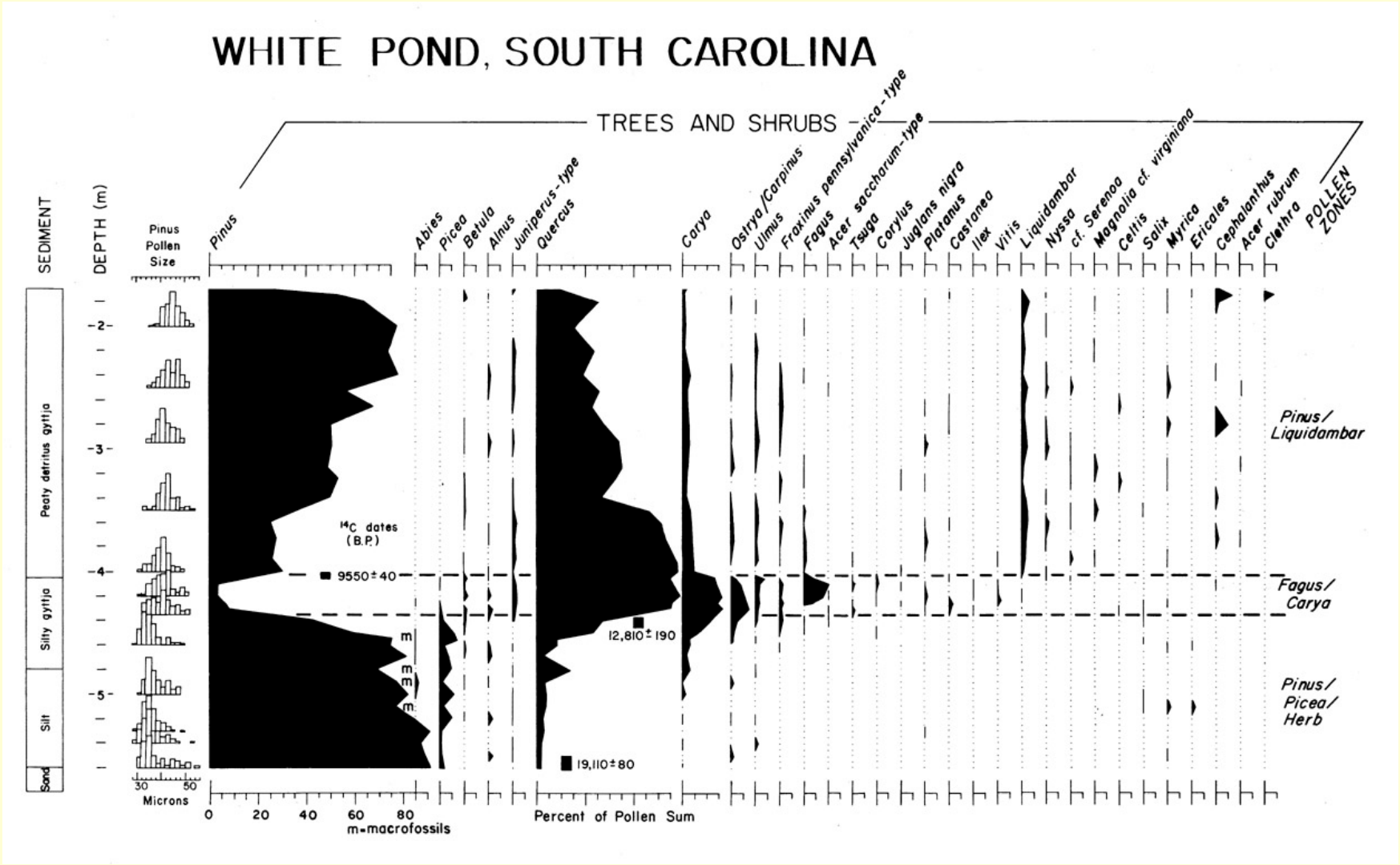
As the climate began to cool, vegetative associations retracted about 5,000 years ago to their present assemblages. Oak and pine dominated much of the Southeastern US. Chestnut was an important component in the southern Appalachians.



Temperature trends over the past 20 thousand years.



Megafauna that went extinct at the end of the Ice Age



Pollen profile over the past 18 thousand years

Mt. LeConte, GSNP

Today spruce-fir forests dominate the tops of the highest mountains, pine types occupy exposed ridges while laurel slicks occupy others. Side slopes are mostly mixed hardwoods (predominantly oak species); coves are dominated by mesophytic species like yellow-poplar, basswood, and buckeye.

Arrival of Man

About 12,000 years ago, man made his way into the Americas. These early Americans were hunter-gatherers and quickly moved into the Southeast, including the southern Appalachians – although in small numbers. Living was easier in the Piedmont and Coastal Plains.

The Clovis people (12,000 – 10,500 years ago) hunted the mastodons, mammoths, giant bison, and other megafauna of the Southeast, as well as deer, elk, and smaller mammals. Some theorize they hunted certain species to extinction, although this is certainly open to question.

These early people were not mere observers of nature; they manipulated the environment for their benefit. As a result of man, a new disturbance regime began – a regime of frequent burning in seasons others than summer.

Paleolithic hunters killing a buffalo in a swamp

Much like modern man, Indians manipulated the environment to enhance their chances of survival and improve the quality of life. These descendents of Eurasian people brought their ancient tool that could change landscapes: fire. They had used fire for thousands of years and no doubt were very familiar with its potential.

Fire was used to: enhance food production, control pests, provide warmth, cook food, drive game, improve habitat, reduce concealment of predators, expose acorns and chestnuts, open travel corridors, etc. Over 80 specific uses of fire by Indians have been identified.

Man's use of fire was a major factor influencing vegetative patterns in the Southeast for millennia.

The frequent fires of prehistoric humans established and maintained the open forest, savannas, and prairies observed by the first Europeans 500 years ago.

Indian populations gradually increased over the millennia. During the Mississippian Culture (1,300 – 400 years BP), maize, squash, and beans were cultivated and large native populations developed throughout the SE. It is estimated that 1.5 to 2 million people populated the southeast 500 years ago and that as many as 250,000 Indians lived in the southern Appalachians at the time of Columbus.

Increased fire frequency (predominantly anthropogenic) and a warm, dry climate provided the conditions conducive to the dominance of oak, hickory, and southern pines. These were not necessarily closed stands.

Indians harvesting maize

Evidence of Indian Burning in the Appalachian Mountains

- **Many prairie areas – Asheville Basin, Shenandoah Valley, Big Meadow, Cades Cove, etc., described by early explorers**
- **DeSoto marched an army of 600+ men, horses, and swine over the mountains in 8 days in 1540**
- **Early settlers are documented to have adopted Indian practices of burning and continued to burn the mountains until the 1920's**
- **Charcoal/pollen record from Horse Cove, NC**
- **Dozens of anecdotal accounts**

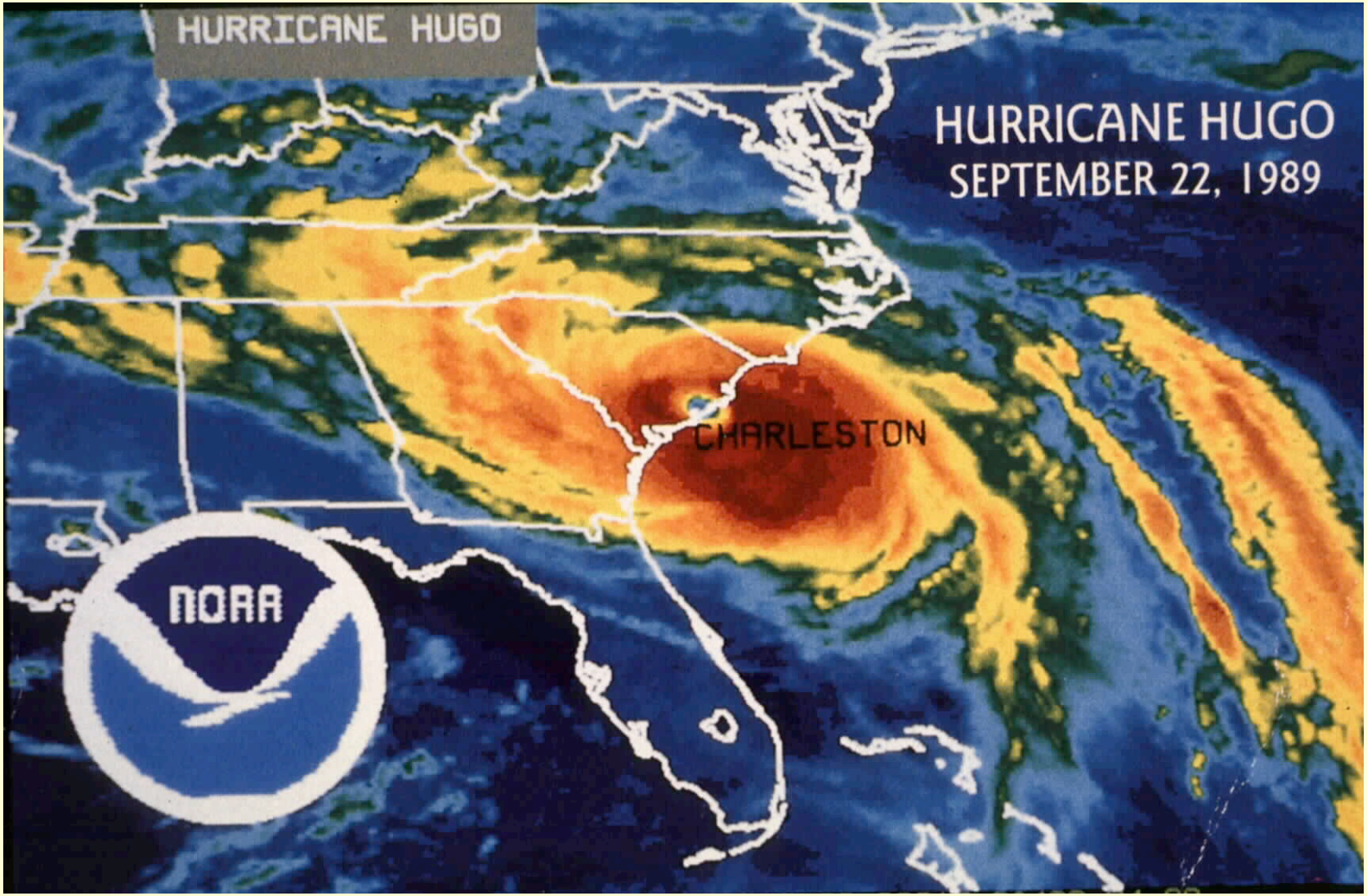
This Burning Regime

- **Created forests that were more open and park-like**
- **Favored oaks, chestnut, hickories, and pines over mesophytic species like yellow-poplar, American beech, and red maple**
- **Because frequent burning had been the norm for millennia, the fire exclusion policy of the last century could be considered a major disturbance, *i.e.*, a deviation from the norm of previous millennia**

Oak woodlands, such as this, were common in mountains

Disturbances other than Fire

- **Ice and snow storms**
- **Wind damage – hurricanes, tornadoes, microbursts, *etc*.**
- **Insect and disease outbreaks – bark beetles, hemlock adelgid, chestnut blight, *etc*.**
- **Floods and landslides**



Hurricane Hugo impacted over 3 million acres and extended into the mountains of NC and VA, as have many other storms

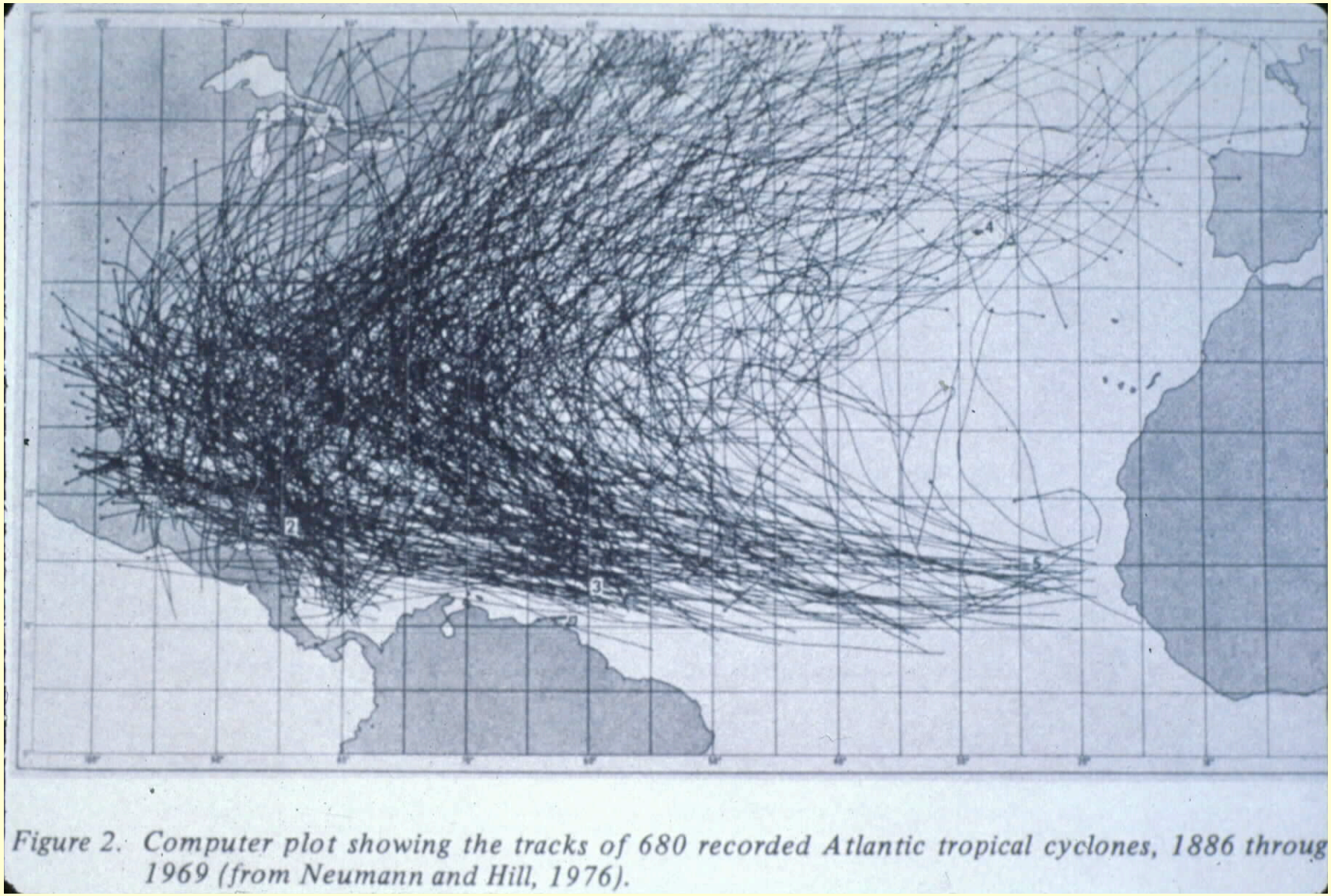


Figure 2. Computer plot showing the tracks of 680 recorded Atlantic tropical cyclones, 1886 throug 1969 (from Neumann and Hill, 1976).

Catastrophic disturbances periodically create large openings in the forest and regenerate to even-age stands

Disturbance events maintain forest ecosystems in a state of continuing change. They occur at different temporal and spatial scales – some are frequent, some are infrequent. Some disturbances affect individual trees while others affect large portions of the landscape.

Disturbances can be caused by natural forces or by man. They maintain diversity and productivity in the landscape. Since man has influenced to varying degrees most ecosystems, shouldn't man be considered part of nature?

When disturbance regimes are altered, ecosystems will change. Managers need to consider historical and prehistorical disturbance regimes as they manipulate forest ecosystems to satisfy the needs and desires of society.

Management Problems Created by New Disturbance Regimes

- **Regeneration problems**
- **Loss of ecosystems**
- **P & T species**
- **Loss of wildlife habitat**

Principles of Disturbance Ecology

- **Disturbances are normal**
- **Large-scale disturbances typically increase landscape or regional diversity, while small-scale disturbances create high diversity at the stand level**
- **Deviation from historical disturbance regimes creates a new structure and composition of forest ecosystems**
- **These changes may cause management problems**

Forests were heavily cutover

Fire was excluded after millennia of frequent burning by Native Americans

Blight eliminated chestnut as a functional component

American chestnut was eliminated in 1920s and 30s as a functional component of southern Appalachian ecosystems

Succession after the Blight

- **On unlogged sites, forest succession following the blight produced an oak association with some mesophytic species**
- **On logged sites, succession proceeded to a mesophytic forest dominated by yellow-poplar, black birch, red maple, and hemlock**
- **Overstory well on way to recovery—successional pathway depends on whether logged or not**

As a result of these disturbances, rhododendron has encroached and now dominates understories of many coves in the southern Appalachians

Rhododendron Dominance

- **Although the overstory canopy is in an advanced stage of recovery, major changes have occurred in the understory**
- **Rhododendron has spread far upslope from the riparian zone it once occupied**
- **This ericaceous shrub now forms dense thickets that reduce species richness and threaten future diversity and productivity of cove forests**

Rosebay rhododendron *(Rhododendron maximum)*

Rhododendron coverage increased during last century

Canopy Gaps and Diversity

- **Canopy-gap dynamics maintain uneven-age stands and are thought to maintain diversity / productivity**
- **When rhododendron dominates understory of canopy gaps, woody species do not grow into the midstory**
- **Are we creating an ericaceous shrub climax?**

Dense shade, acid litter, and allelopathy prevents regeneration of other species under rhododendron

- **Loss of chestnut as a functioning element, exclusion of fire, and heavy logging at the turn of the past century all contributed to the expansion of rhododendron from the riparian forest**
- **American chestnut may have played a role, along with periodic fire, in confining rhododendron to the riparian forest**
- **Extracts of chestnut leaves inhibit germination of rhododendron seeds and reduce radicle growth of unstratified rhododendron seed**

Fire Exclusion and Oak Regeneration

- **Decades of fire exclusion has lead to difficulty in regenerating oak, especially on good sites**
- **Periodic burning opens the understory, xerifies the soil surface, and reduces competition – all of which favors oaks**

Dense shade in the understory inhibits establishment of oaks

Periodic burning (foreground) provides good conditions for oak regeneration and establishment.

Table Mountain/pitch pine stands occupy xeric ridges and are in decline as a result of fire exclusion.

Fire Exclusion in Table Mountain/ Pitch Pine Ecosystems

- In absence of fire, mountain laurel and scrub hardwoods dominate the understory
- Pine regeneration is impossible under these conditions
- Understory plant diversity and wildlife habitat value are low

Understory Burning in Table Mountain / Pitch Pine Ecosystems

- Four understory burns over 12 years created a pine woodland
- Understory plant diversity has increased
- Warm-season grasses are present
- Wildlife habitat has improved

CONCLUSIONS

- **Disturbances are normal and maintain diversity at both the landscape and stand level**
- **Anthropogenic fire has played a major role for millennia in shaping certain ecosystems of the southern Appalachians**
- **Fire regimes prior to fire exclusion policies of the last century often created open woodlands, savannahs, and prairies**
- **Changes in disturbance regimes create changes in vegetative structure and composition**

CONCLUSIONS (CONT.)

- **Altering long-established disturbance regimes creates numerous management problems**
- **Managers need to understand the roles of historical disturbance regimes as they attempt to create the desired future conditions expressed by various publics**